The PhD thesis, divided into six chapters, formulated in a logical succession, to which are added the conclusions, proposes an analysis of spatio-temporal evolution of Bistrita subcarpathian valley landscape, where the systemic’s structure components have changed obviously in recent two centuries. The thesis approaches a traditional geographical subject and also of importance through the practical implications at the local level: landscape dynamics, aiming to expand and diversify the subject in terms of conceptual and methodological. Given the integrated nature of the concept of landscape, the thesis stands as the first approach of broader synthesis of the geographic territory.

**The first chapter, General aspects regarding PhD thesis**, is meant to argue the motivation of the study, to establish the initial hypotheses and to set the main objectives. The landscape is the result of interactions between the physical-geographical components and human activity, a complex system evolving constantly. Its study requires an interdisciplinary approach, from a systemic point of view. Due to the complexity of the topic chosen, we assume that the systemic approach, with proper use of GIS techniques is the most appropriate method for analysing the dynamics of the "landscape system " and gives to this scientific approach coherence and a complex character, corresponding to the complexity of the systemic structures that the landscape express.

The chapter also describes the geographical framework, which corresponds to the needs related to fixing the limits or the study area, and provides a brief retrospective analysis on the current state of knowledge in the proposed area.

**The second chapter** explores some theoretical aspects, achieving the theoretical substantiation of the concepts considered. Was analyzed semantically and chronologically the evolution of the landscape concept by presenting the main ideas initiated by the renowned schools which aimed to study the landscape, both internationally and nationally.

Based on the specialized literature, quite rich but non unitary, was tried to define the concept of landscape, in order to match with the purpose of the thesis. The paper has approached the landscape issue based on the graphical representation of J. C. Wieber, which proposes a systemic point of view. Thus, the landscape may be defined as a spatial unit, more or less complex, characterized by a structural and functional state, resulting from the interactions of the physical and geographical components and human activity, which generates a physiognomy of its own and is urse in relation to the way of perception.
The third chapter presents the methodology and structuring the scientific analysis, which showcases the work stages, databases and methods used, emphasizing the procedures and working techniques, in which the most prevailing were interpretation and representation of data using GIS tools.

The theme of the thesis required three types of approaches: diachronic, analysing the phenomena in evolutionary terms, according to the available cartographic materials; diagnosis (radiography of the current state) and a prognostic one (projections about future developments).

The validity of the results can be achieved by concomitant use of classical and modern means of research. The main methods used in the analysis are inductive and deductive methods, observation, synthesis, scientific analysis, mapping - GIS techniques, comparison, historical and experimental methods, etc.. The analysis was conducted using a series of professional softwares specific to GIS environment, especially Microimages TNT Mips 7.2, ArcGIS 10.1 and Global Mapper, but also we benefit of the advantages of Open Source softwares (Grass, QGIS).

The fourth chapter, Structural and functional analysis of landscape system changes in Bistrita subcarpathian valley, is the most representative as percentage and especially in terms of satisfying the main objectives of the research initially established. Landscape, as systemic spatial unit, is expressed through the interactive relations between the three basic components (abiotic, biotic and anthropogenic), that determine the dynamic processes and its evolution. Thus, in this chapter are analyzed in structural and functional terms, the changes in each component of the landscape system, highlighting, of course, their role in the whole structure.

There are analyzed in a first phase the ecological support changes, focusing on the geological substrate and relief, considered coordinating factors of the landscape, both because of the visual impact, and also in terms of their role in the evolution of the other structural elements. There are noted the relief morphometry analyses, possible due to the digital elevation model made at high resolution, which served also to further GIS applications. In this respect, can be noted the successful application of the TPI model (Topographic Position Index), which allows the identification and automatic classification of landforms, with an important role in achieving a coherent typology of the landscape.

This subchapter analyzed also the anthropogenic landforms, which were graphically represented both through a series of suggestive pictures, and through specific GIS modeling methods. The resulted anthropogenic landforms were divided into excavation landforms (canals, cuttings, quarries etc.) or accumulation landforms (embankments, dumps, dams or dikes).
Climatic elements, though less “visible” because of their air manifestation, by their dynamics and the rapid pace of changing, play a very leading role in the dynamic of the system processes. Thus, the landscape is mainly a result of climatic evolution. The climate acts differently, shaping and creating the conditions for defining landscapes. The seasons succession, with all the specific phenomena determine specific types of landscape (winter landscape, autumn etc.). Also, the manifestation of particular climatic phenomena and processes contribute to defining the landscape at different times of the year and has especially negative implications for the human activities.

The analysis of the climate was achieved by using a long string of statistical data (1961 - 2006), which were interpreted in the GIS environment, resulting a series of charts and cartographic materials representative for the analyzed parameters.

The most dynamic character of the abiotic component is given by the hydrographic network, the main changes aiming the riverbed. These changes, mostly human induced, were materialized through the hydrotechnical works undertaken for socio-economic development purposes. The analysis of the riverbed was performed by extracting the morphometric information from the maps and their interpretation based on two coefficients, and also by comparing the maps for certain temporal sequence. These actions have led to significant changes regarding the hydrographic network morphometry, by reducing the length of the river, degreasing unplait or sinuosity index.

Vegetation changes were analyzed through the diachronic analysis of the area occupied by forests based on the available maps from different periods, showing the areas affected by deforestation but also those with afforestation. To establish the consequences of changing forestry areas was achieved the naturality index, applied to the four periods considered. There have been recorded remarkable changes, not only over the entire investigated period, but also between the individual time horizons. The balance of these afforestation – deforestation actions in Bistrita subcarpathian valley during 1788 – 2006 has a negative value, which resulted in significant reduction of forestry areas, leading to the disturbance ration between cutting capacity and the power to restore forests in a natural way, with negative systemic implications.

The importance of studying soil cover in this analysis is given by the role of receptor and indicator that it plays in the dynamics of landscape system. It has been analysed according to the speciality methodology, achieving a soil map processed after Lupașcu (1996) and adapted to the current soil taxonomy. Their high quality
favored the practice of intensive agricultural activities, the terraces being mainly occupied by arable land.

**Land use and the resulted anthropical transformations**

The human factor, through its actions, imposed to a great extent the change of the natural ones. Therefore, an important part of the thesis was occupied by structural and functional analysis of the systemic components in relation to anthropogenic use.

**Land use change** analysis represents an important part of the thesis because of the far-reaching effects of human activities on modern landscapes. Due to the use of cartographic materials from different periods and at different scales, the analysis of environmental components was made from two perspectives: qualitative and quantitative. The analysis of cartographic documents was realised both from a statical point of view, in which the elements were analyzed as a whole in each map and dynamic, which tracked the evolution of each component.

Qualitative analysis was applied by using all map strings at close the available scales, from to Austrian map since the 1788/1790 also until imagery of the current period. The purpose of using these maps was to capture certain patterns of development over time, and to explain the causes of these phenomena. Although we experienced some geometric mapping errors, different projection systems, some being non-unitary maps made for specific purposes, rather large scales which are made all the extraction of cartographic materials allowed certain common elements of analysis which have could highlight areas that remain constant, especially those who have a strong dynamic. Visual analysis of multi-temporal cartographic documents reflected a high rate of change in land use during 1788-1986. During this period we first highlight a significant loss in terms of forest area, particularly for arable land or building perimeter. The main cause of this phenomenon is the demographic factor, the increase in the number of people with their needs implied by imposing a territorial extension of built area and of course, new arable land.

The qualitative analysis was applied to all available map strings at close scales, from the Austrian maps since 1788/1790, until the aerial imagery from recent times. The purpose of using these maps was to capture certain patterns of evolution over time, and to explain the causes of the phenomena. Although we experienced some geometric mapping errors, different projection systems, some of them being non-unitary and made for specific purposes, the large scale of all maps allowed us the extraction of certain common elements, from which could be highlighted the areas that remain constant, especially those that have an accentuated dynamics. The visual analysis of these multi-temporal cartographic documents reflected a high rate of land use change during 1788 – 1986. During this period can be seen at
first a significant loss regarding the forestry areas, especially in favor of arable land or built-up perimeter. The main cause of this phenomenon is the demographic factor, the increase of the population number and their implied needs imposing a territorial extension of built-up area and, of course, new arable land.

The quantitative analysis is based on geostatistical methods to quantify changes in land use categories. This type of analysis was made after processing the latest cartographic documents at detailed scales, that allow us to quantify precisely and as close to reality of each element’s surfaces and, also a relevant diachronic analysis. Applying this method shows satisfactory results and, by their correlation with different events and natural phenomena, we can highlight the causes that led to these changes. The categories with the largest areas that have undergone significant changes are arable land, forests, pastures and built-up areas, which has the highest rate of growth.

Because of the importance of the agriculture for the region, was made a case study to Podoleni commune, which can serve as a model for the entire study area. The case study analysed in detail the major changes in the agricultural sector (types of crops, owners association etc.).

Regarding the evolution of anthropic structures and their impact on the landscape, we considered useful to analyse the influence of demographic, economic, historical and political factors on the landscape dynamics, due to the coordinating role of each one of them. To highlight these dynamic aspects, were used a large number of statistical data that provided rich information, by which were established functional relations in the landscape system.

The analysis of human pressure evolution through the territorial expansion has determined, with the help of GIS techniques, the density of built-up area changes, for the whole investigated period. Thus were identified the dynamic areas in spatio-temporal terms, on which can be captured certain patterns of evolution for each period.

In this section was conducted a case study applied to Piatra Neamt city regarding the territorial expansion depending on the favorability for construction, in which are identified the opportune, but also the restrictive areas in relation to built-up space. The case study was achieved through a GIS application that uses several parameters (in this case slope, slope orientation and accessibility). The results showed that the territorial expansion was made first on the favorable areas, however, due to reaching the saturation level of buildings in most favorable areas, it was necessary to extend to areas less favorable.

Regarding the built-up area analysis has to be mentioned the case study concerning the typology of buildings by height, made for Piatra Neamț, a city which is representative for the socio-economic development of the entire region.
The results showed a predominance of buildings up to 2 floors, the ones with the highest regime being found in the former neighborhoods of the socialist workers. The analysis showed various forms and functions of the buildings, largely reflecting the historical particularities, and especially local geographical conditions.

The thesis placed particular emphasis on the analysis of changes in the industrial sector, which radically transformed after 1989, through a detailed analysis of the evolution of the three major industrial platforms in the study area: Piatra Neamț, Săvinești-Roznov and Buhis. The study identified certain conversion models of industrial landscape of the three locations, and finally attempted to provide viable solutions to reintroduce them into economic circuit.

Bistrița subcarpathian Valley has known a contradictory evolution, oscillating between progress, stagnation and regression, and directly influenced the socio-economic aspects of the whole territory. Due to geographical position, the proximity to quality water sources, favorable land for building, and the positive socio-economic aspects (developed communication ways that facilitate the exchange of materials, cheap and abundant labor, commercial tradition of the territory) made Bistrița subcarpathian Valley a suitable area for the growth of the industry and a reference point at national level in certain activity sectors. Nevertheless, Bistrița subcarpathian Valley industry still shows an important role in relation to the economy area.

The role of the transportation network in the structure and functionality of the landscape is well highlighted, through a detailed analysis of its evolution and the resulted changes. Both from the quantitative and qualitative analysis (which aims the density of the road network on a unit area), it was observed its densification and continuous development as a result of technological progress. Also, it was conducted an analysis based on “buffer zones”, which aims to identify the changes in areas surrounding roads. The geostatistical analysis revealed that the development of the road network directly affects the land use, especially by expanding the human actions over the natural factors.

The fifth chapter covers the identification and mapping the main types of landscapes in Bistrita subcarpathian valley. Although it was a difficult demarche, this analysis was absolutely necessary because of topic chosen. Following the analysis of different classification criteria proposed by the speciality literature, the thesis uses a genetic-evolutionary classification, adapted to the specific of the study area. Thus, the analysis distinguished three main types of landscapes: natural, humanized and anthropic.

Regarding the identification and mapping of the main types of landscape in Bistrita subcarpathian Valley, it was considered appropriate to adapt the European
Urban Atlas methodology of land use, proposed by the European Environment Agency, starting from the premise that each category of land use has a dominant feature of the landscape, which gives it a certain specificity.

**The sixth chapter** presents some *methods of analysing and assessment the landscape through gis applications*, using the latest techniques in the domain, and developing new analytical methods.

Such a methodology was achieved for the analysis and assessment of visual quality of the landscape, applied to Piatra Neamț municipality, which is based on a mathematical formula for quantifying the landscape, created by Neuray (1987), being developed using environmental geographic information.

In the second part of the chapter have been calculated a number of specific indicators of landscape, applied to the area of study using Open Source GIS softwares (GRASS and QGIS). The results of the analysis proved the utility of these indicators in quantifying the structural evolution of the landscape, and highlighted the advantages of using Open Source software.

**CONCLUSIONS**

✓ The thesis aimed to achieve a reconstitution of the existing landscape of Bistrița subcarpathian Valley, on a range of more than two centuries, through the use of a complex system of digital tools, which, although it was a difficult approach, we consider that it provided us improved results as opposed to using only traditional means of research. Being a systemic spatial unit, the landscape is dynamic and constantly changing. The analysis of landscape dynamics has proven to be essential in achieving the ultimate goal of the thesis, because these dynamic processes are meant to control the state of the landscape and to determine its evolution.

✓ Due to the complexity of the topic chosen, the thesis differs from other approaches of this type through the systemic analysis of the landscape concept, in which the proper use of GIS techniques represented the main means of accomplishing the work. Creating the cartographic basis using the detailed maps (1:5,000), although it was a time-consuming step of the scientific approach, allowed us conducting a remarkable fidelity analysis in relation to the territorial realities.

✓ The originality of the thesis consists also in developing a methodological and operational vision of analysing the structural and functional changes of the landscape system’s components, that can be a solid starting point for other approaches of this kind.
Concerning our analysis, some remarkable changes have been recorded, not only over the entire investigated period, but also between the individual time horizons, where the different dynamics of the individual land cover types is shown most clearly. In addition to the information on absolute changes, the information on the rate of change is also of very high importance, as the rate of change differs according to the time horizons (Skalos et al., 2010).

Anthropic structures represents the most dynamic component of the landscape, the increasing human pressure leading to significant changes to the other components, with obvious implications on landscape system physiognomy and functionality.

According to the degree of anthropogenic intervention, we tried also to achieve a more complete typology of the landscapes in Bistrita subcarpathian valley, which have been identified and mapped using a methodology adapted to our study area. This approach allowed us to highlight the distinctive features that define Bistrita subcarpathian valley as a spatial unit, which gives it its own functionality.

The thesis is distinguished by the use and adaptation of some of the latest methods of analysis in the field and tries to propose new methods that have proven their utility by applying to the studied area. It should be noted that most of the methods and results of the thesis have been scientifically validated through the publication of articles in scientific journals with international recognition. These methods aim to achieve repeatable approaches in analyzing and evaluating the landscape, which could be a useful tool for policy makers and local actions.

The results confirm that the developed methods are appropriate to the landscape dynamics analysis, proving their utility mainly in planning processes and territorial planning, which can be used to manage and monitor land resources, to assess the impact of human activities on the environment, and also for certain land use category expansion necessities. The utility is also given by the acquisition and creation of a complex database, necessary for the elaboration of this thesis, hoping that the final results will prove useful for future development directions of the territory.
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